Sentinel-3: Topography Mission Readiness

➔ COPERNICUS OCEAN AND GLOBAL LAND MISSION

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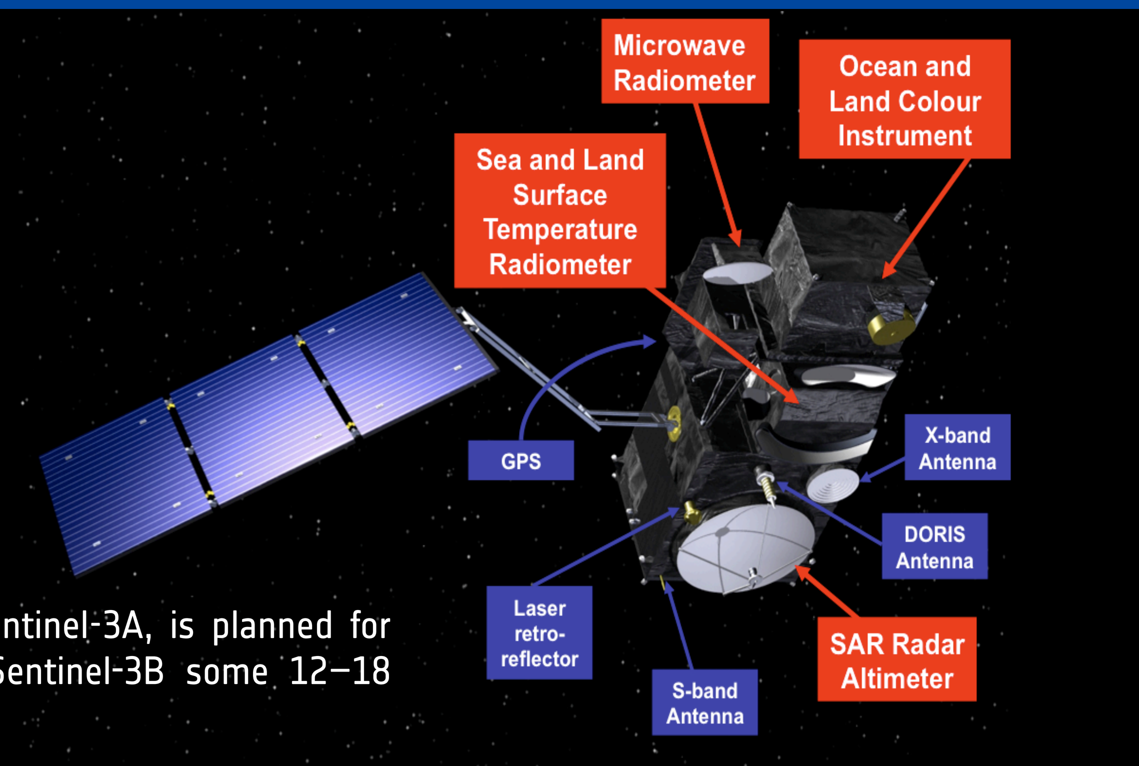


The launch of the first satellite, Sentinel-3A, is planned for 3rd quarter 2015, the launch of Sentinel-3B some 12–18 months later.

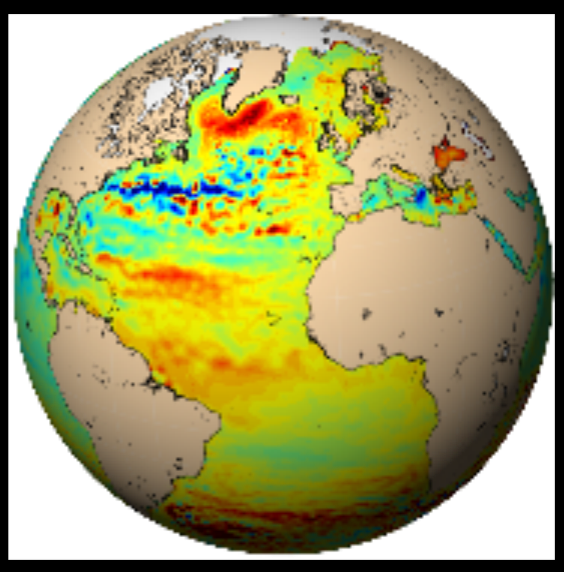
➔ The Sentinel-3 Topography Mission

Sentinel-3 will fly a new surface topography payload in support of Copernicus services. The aim of the S-3 topography payload is to provide continuity to the precise range and normalized backscatter (σ^0) measurements of ENVISAT RA-2 and Cryosat altimeters. From these measurements estimates of sea surface height, wind speed and significant wave height will be derived in an operational manner in support of Copernicus services. The Sentinel-3 Topography Mission includes the following payload elements:

- A dual-frequency SAR altimeter, derived from CryoSat SIRAL and Jason-2/Poseidon-3 heritage called the SAR Radar ALtimeter (SRAL) instrument.
- A Microwave Radiometer (MWR) instrument, which supports the SRAL to achieve the overall altimeter mission performance by providing the wet atmosphere correction derived from ENVISAT MWR heritage.
- A Precise Orbit Determination (POD) package including a Global Navigation Satellite Systems (GNSS) instrument, a Doppler Orbit determination and Radio-positioning Integrated on Satellite (DORIS) instrument and a Laser retro-reflector (LRR).

➔ Measurements

- Sea Surface Height →
- Significant Wave Height
- Wind Speed
- Sea Ice thickness (freeboard)
- Ice Sheet surface elevation
- Inland Water surface elevation
- Atmosph. Water Content



➔ Orbit definition

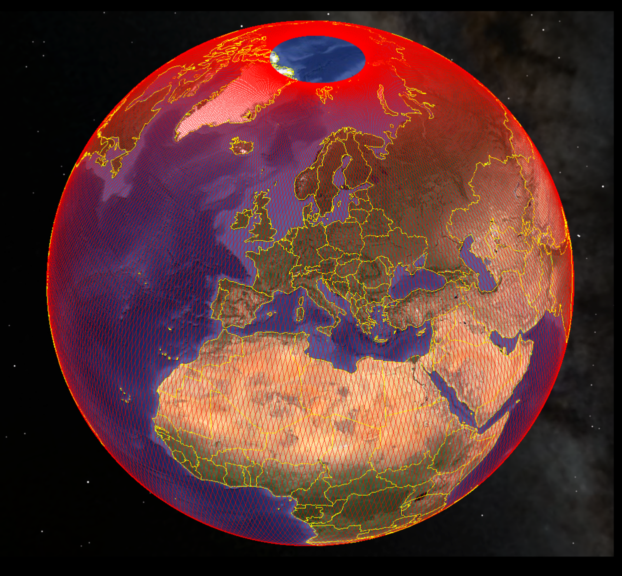
The orbit selected has been the result of a trade-off between the constraints imposed by all sensors and operational constraints based on requirements for:

- a short revisit time for the optical instruments, which imposed an orbit subcycle of 4 days;
- a long orbit cycle, implying short spacing between ground tracks, suitable for mesoscale (100–300 km) ocean topography

The resulting orbit is polar, Sun-synchronous (98.6° inclination), with a mean altitude of 815 km and a repeat cycle of 27 days (14 + 7/27 revolutions per day). The local time of the equator crossing (LTDN) is 10:00 a.m.

The second satellite will be placed in the same orbit with an offset of 180°, such that its ground track falls exactly in the middle of the ground tracks of the first satellite, thus optimising payload coverage while maintaining a balance between topography and optical mission coverage.
In a two-satellite configuration, after one complete cycle, the inter-track separation will be reduced to 52 km at the equator.

Sentinel-3A and -3B ground tracks can be downloaded in Google Earth KML format from: sentinel.esa.int



Sentinel-3 ground tracks offer a triple cross-over over Crete between S3A, S3B and Jason-2.
A calibration site hosting a transponder is being established on this point.

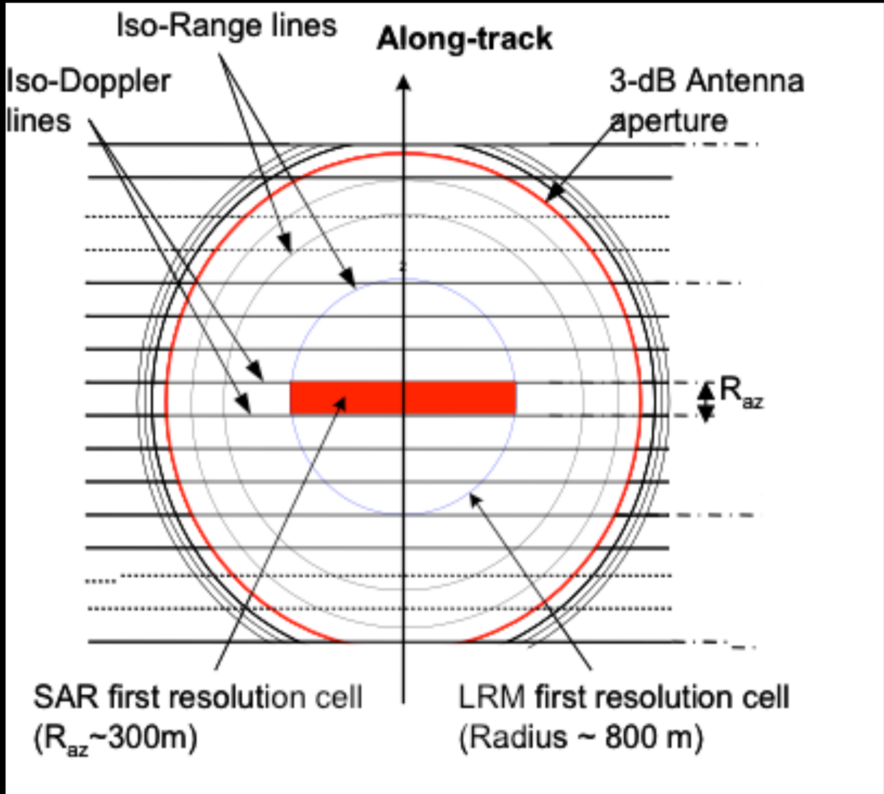
➔ Topography Instrument operations

Topography instrument operations are repetitive according to the satellite position, with respect to the geographical area being overflown:

- SRAL modes are fixed over specific geographical areas and commanded via the Orbit Position Schedule (see below), and
- the MWR channels will always be acquiring data, and the GPS receiver and DORIS will be in continuous operation.

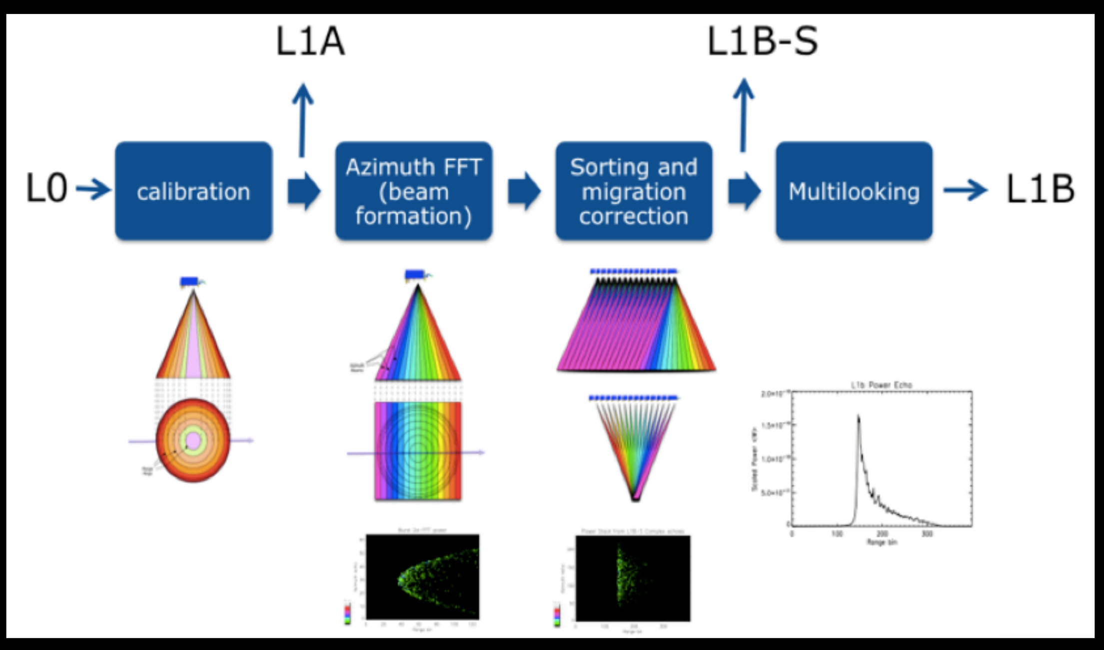
The operation modes for the altimeter SRAL are the classical Low-Resolution Mode (LRM) or the Synthetic Aperture Mode along-track (SAR) with enhanced resolution. The mode, and the switching between open- and closed-loop tracking are defined by a geographical map, called Zone Data Base (ZDB). The intersections of the groundtrack with the areas defined in the ZDB are translated into the actual commands to the altimeter uploaded via the Orbit Position Schedule for a full repeat cycle. The LRM mode was originally planned to be used over the open ocean (300 km offshore) and ice sheet interiors, while the SAR mode was planned to be employed for all other areas.

➔ Sentinel-3 foresees to extend the use of SAR mode from the coastal zone to the full ocean to provide high-resolution (~300m along-track), low-noise altimeter data in an operational context for the first time.



During SAR mode, an increased number of waveforms are shot with respect to LRM leading to the following benefit to users:
→Increased resolution along-track
→Improved accuracy over the ocean, and
→scope for better accuracy over other challenging surfaces

➔ Provision of additional L1 data



Product Level	Product Description	Relevance for
L1A	Unpacked L0 complex echoes that have been sorted and calibrated (including geolocation information)	SAR processing specialists allowing fundamental studies on SAR processing such as Doppler beam formation and calibration studies using ground based Transponders
L1B-S	Complex (I and Q) echoes after slant/Doppler range correction (geolocated)	Geopphysical retrieval algorithm developers (over ocean, land and ice surfaces), surface characterisation studies (e.g. impact of sea state bias, wave directional effects etc.) and QC systems
L1B	Geo-located, calibrated Multilooked power waveforms	Geophysical retrieval algorithm developers and QC systems

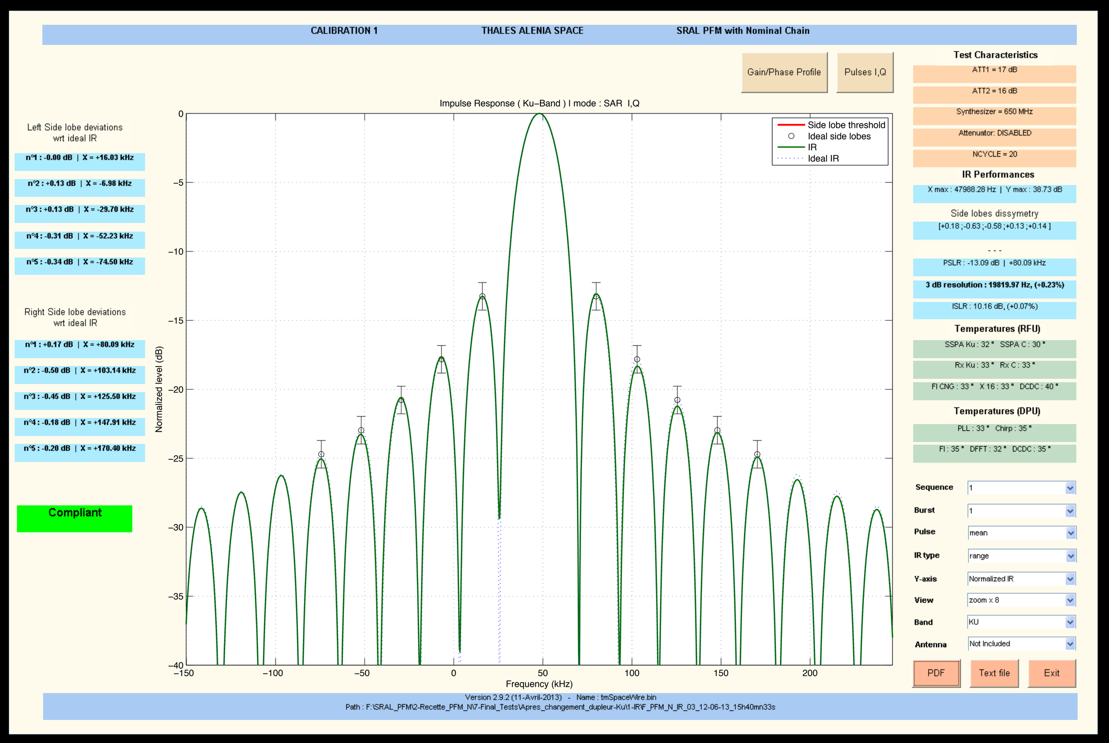
➔ Two tracking modes

Traditionally in SAR mode, autonomous closed-loop tracking of range and gain are used where the altimeter range window is autonomously positioned based on-board analysis of previous SRAL waveforms. Alternatively, an open-loop tracking mode is available where the altimeter range window is positioned using a-priori knowledge of the surface height stored on-board the instrument in a one-dimensional along-track Digital Elevation Model (DEM). This open-loop mode facilitates acquisition over rough terrain and ensures continuous acquisitions across sea/land sea/ice transition zones. A key advantage of open-loop tracking is that data loss typical of conventional closed-loop tracking due to mode switching and loss of track during transitions or over variable terrain are minimised.

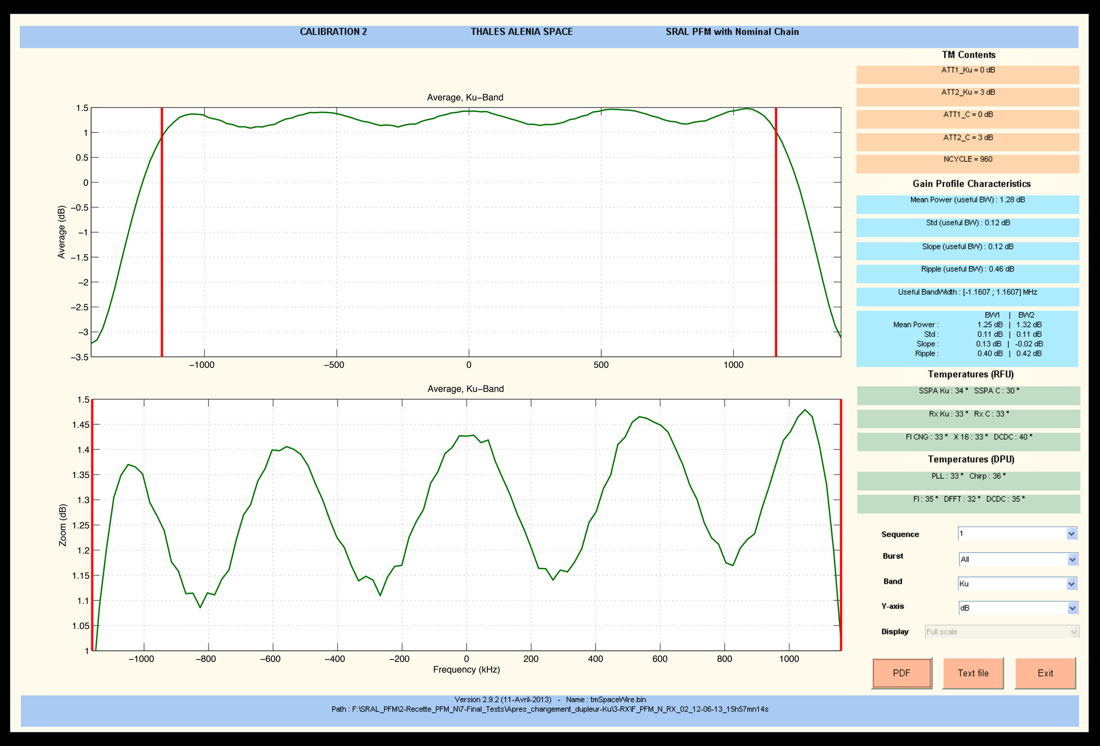
➔ SRAL modes vs observed surfaces

Surface type	Measurement mode	Tracking mode
Open ocean	SAR	Open loop
Coastal zones	SAR	Open loop
Sea ice	SAR	Open loop
Ice sheet interiors	SAR	Closed loop
Ice sheet margins	SAR	Open loop
In-land water	SAR	Open loop/Closed loop

➔ SRAL PFM performance



Impulse Response function (CAL-1) Ku-band/SAR-mode/Nominal chain



Receive chain amplitude response (CAL-2)

➔ Commissioning approach

4 cycles of Cal/Val
- 1 full cycle LRM in closed loop mode
- 1 full cycle in SAR mode with some areas in open loop tracking
- 1 full cycle in SAR mode with increased open loop tracking
- 1 full cycle in SAR mode with almost full open loop tracking

European Space Agency